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Toward A New Progressive Theory of Learning: A Critical Deconstruction and Synthesis of Three Learning Theories

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Toward A New Progressive Theory of Learning: A Critical Deconstruction and Synthesis of Three Learning Theories

by

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Report

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Education

The University of Texas at Austin

May 2013

Dedication

I would like to dedicate this report to the steadfast and loving support of my husband, Duane and daughter, Trinity. Without their support and understanding, I would not be where I am today.

Acknowledgements

I would like to acknowledge my advisor, Diane Schallert for her support and assistance. She was always encouraging and positive, with great feedback. This report would not be possible without her. I would also like to acknowledge Marie-Anne Suizzo for her inspiration and support that helped me to conceive this report. Lastly, I would like to acknowledge the faculty of the Educational Psychology department. My time at The University of Texas has been both the most intellectually challenging and rewarding time in my life, and I am forever grateful.

Abstract

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Understanding how students learn, that is, how they recognize, process, and internalize new information, is vital to any teacher's success. Although many theories exist in this field, I have selected three strong theories to initiate a discussion that I see as suggestive of a new, cohesive theory that represents a synthesis of all three.

For the purposes of this report, I have selected the theories of constructivism and social constructivism from Piaget and Vygotsky, Bronfenbrenner's Ecological Systems theory, and Chaos theory as the basis for my proposed model. In the report, these three theories are deconstructed, and various components of each are then synthesized to suggest a comprehensive model.

It is my intent that my proposed model be helpful to teachers in designing and tailoring instruction for their students. By understanding the relationships and inter-relationships of the child to the various systems that affect him/her, the teacher can better engage all students toward a successful outcome.

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Chapter 1: Introduction

As a teacher at both the middle and high school levels, I developed a curiosity and interest in why some students learned concepts easily, while others struggled. Both groups had had seemingly equivalent preparations leading up to my classes, but contrary to expectations, they differed greatly in their abilities to apply and translate what they had previously learned for the activities they encountered in my class. Over many frustrating years, I concluded that I needed to seek out a more information on how and why we learn, and how we internalize and apply what we have learned. My goal was to understand better how one might reduce the chaos within the system by appropriate groupings and tailored instruction in order to help to reduce other variables (such as feelings of inadequacy, fear, embarrassment, and intimidation) that can interfere with the construction of knowledge. I also wanted to understand ways to eliminate feelings of boredom in more advanced students, lowering the tendency to act out, distract, or lose interest.

My goal in writing this paper was to draw on my growing conception of the dynamic system of the individual in order to offer teachers a tool and a guide by which they could identify variables within their classrooms and use these variables to help them understand their students' pre-existing knowledge, to tailor instruction more suitably for all involved parties.

When I began my graduate studies, I was enthralled from my very first class. As we explored the various theories for learning and teaching such as behaviorism, constructivism, and socio-constructivism, I began to feel overwhelmed at the vastness of the theories that were laid out before me. I recall on one day when we were discussing how meta-knowledge, meta-beliefs and other pre-existing conditions could alter how an

individual processes information and learns, when the concept of chaos theory as a model for pre-existing knowledge and conditions came to me.

My familiarity with chaos theory did not come from previous psychological or educational research, but rather from my previous career as an engineer. In dealing with manufacturing, chaos theory is a well recognized theory to help map and understand defects and seemingly random errors in complex systems. I was also aware of the concept from my schooling in theoretical physics, a discipline that had borrowed the concept from its origins in biology.

From this spark of a connection between the complexity of understanding how individuals learn and chaos theory erupted a new interest, a goal of attempting to put the two together. I did some preliminary research on the intersection of learning theory and chaos theory, and found some to be enlightening and others to be confounding. As my education continued, I was exposed to more theories and more ideas that further broadened my depth of understanding of the learning process. The more individualized I found learning to be, the more I felt that chaos theory was, in some way, key to understanding, and somehow compensating for the diversity among theories.

In my last semester of classes, I was introduced to a theory that came the closest of any to my interpretation of chaos theory, Bonfenbrenner's Ecological Theory. Within Bronfenbrenner's model, specifically his later model with the passage of time taken into account, I found a foundation to allow my interpretation of chaos theory to build. To understand Bronfenbrenner's theory better, I analyzed its history, where and when the initial idea may have originated and why and how the originators were influenced, and the theory's evolution to it's current state. Bronfenbrenner's model took into account the many different "systems" or variables that can affect an individual and his/her processing of information into knowledge. Although his model was quite comprehensive, for my

purposes I found it to be still too limiting. So I began to research dynamic modeling, an attempt to interpret chaos theory and apply it to complex systems.

It was then I discovered the G. Mayer-Kress model for global climate change. This model had been developed to illustrate a model of a dynamic system, in this case, global climate change. The model involved all the researched variables that were either affected by climate change or contributors to climate change. Once I had the concept of how to build a dynamic model, I returned to Bronfenbrenner's Ecological model for guidance on the systems or variables that should be represented to understand human learning. Seeing the need for a phased chronological approach, I utilized the life stages associated with the public school system in much of the United States, namely pre-school, elementary school, middle school, and high-school. To round out the full model, I added a life stage I termed infancy that encompassed the time-frame prior to organized schooling.

From there, the model that I present in Chapter 5 of this paper took shape. Using the theories and ideas of Vygotsky and Piaget, I was able to make estimations of the variables, or "systems" that would influence each life stage of the individual. Piaget's concepts of assimilation and accommodation and Vygotsky's social construction of knowledge were essential in determining when and why some of the associations and systems occur within my models at different stages, especially the jump in systems when the child enters public elementary school and the social context changes so dramatically. To understand better Piaget's and Vygotsky's theories, I analyzed the history of each, where and when the ideas may have originated and why and how the originators were influenced, and the evolution of theories to their current states.

The goal of my model is to elucidate the influences on the individual at each life stage so that they can be accounted for and anticipated, allowing the teacher to tailor

specific approaches to the individual student. Ultimately, this model could also be adapted to group students into more productive groupings so that, with common or diverse knowledge, constructivistic approaches may be more useful. It may also allow the teacher to know what balance of direct instruction and group work would be most effective for which groupings.

The ability to reduce the chaos within the system by appropriate groupings and tailored instruction may help to reduce other variables that can interfere with the construction of knowledge such as feelings of inadequacy, fear, embarrassment, and intimidation. It may also help to eliminate feelings of boredom in more advanced students, lowering the tendency to act out, distract, or lose interest.

Although I attempted to make my model as comprehensive as possible, there are assumptions made regarding the environment of the individual that are stated in the model that shape the variables and systems therein. These assumptions limit the application of this model directly to many situations that are not aligned with them and should be taken into account before the model is applied. Any changes in these assumptions should result in changes to the model, the systems and variables. In fact, model is meant to be a guide to the construction of models unique to each situation where it is applied.

Chapter 2: Constructivism

In this chapter, I will explore two of the main educational theorists that are considered by many to be central to theories of learning and development, Piaget and Vygotsky. I will detail their individual theories and, where possible provide the roots of their inspiration.

Constructivism is broadly defined as the theory that learners come into an educational setting with prior knowledge, skills, beliefs, and concepts that assist them in constructing solutions to problems leading them to construct new knowledge (Lam, 2011).

I will begin by discussing the constructivist theories of Piaget, then move into socio-constructivism and Vygotsky, including the influences of Socrates, Plato, and Dewey. The roots of constructivism lay heavily in politics and philosophy. Although many different philosophers and educational theorists have been involved with the theory on one level or another, Socrates, as represented in the writings of his student, Plato, may have been the first constructivist.

PIAGET AND CONSTRUCTIVISM

Piaget's interest in children's intellectual development began when he worked with Alfred Binet perfecting Binet's intelligence test (Smith, 2007). From an early age, Piaget was interested in the natural sciences and obtained a Ph.D. from the University of Neuchatel directly following high school. He was exposed to psychoanalysis after spending time at the University of Zurich before going to France to work with Binet (Smith, 2007).

In working with Binet, Piaget discovered a pattern in the questions that were consistently missed by the students taking the intelligence test, he developed a theory that such mistakes were not deficiencies in intelligence, but that children were using a different thought process than adults. This led him to begin his investigation of the growth process of the mind (Smith, 2007).

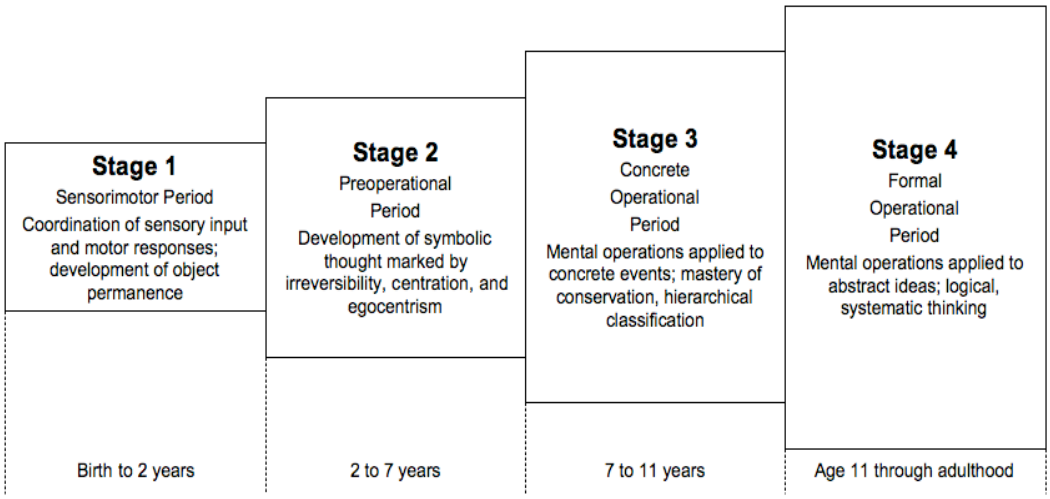

Figure 1: Piaget's Stages of Development (Gaeddert, 2006)

In Figure 1, Piaget's Stages of Development are illustrated. Piaget begins at birth, and progresses through four stages, finishing at adulthood. Piaget postulated that all children progress through these stages, in the order presented above. In the first stage, called the sensorimotor period, the child begins at birth with development limited to simple motor reflexes. As the child matures to age two in this stage, these initially random behaviors begin to coordinate. Children use ply with objects and people to develop during this period. From the sensorimotor stage, children progress to the preoperational stage. Piaget defined this stage to encompass ages two through seven

years. In the preoperational period, the child develops representational skills such as drawing, language, and mental imagery. It is Piaget's opinion that, although language grows at an astounding rate in this period, the child is only aware of the world from their own perspective, unable to understand someone else's viewpoint. They are also unable to grasp dynamic situations and transformations, choosing instead to represent unchanging, static situations (Siegler et al, 2005).

As the child matures, it progresses to the concrete operational stage. At this stage the child begins to be able to see the world from other's perspectives. The child's perception develops to the point of being able to understand transitions and transformations. The child is limited, however, in understanding only physical situations, and is often satisfied with discovering one outcome, even if other, better, outcomes exist. It is not until the child enters the formal operations stage at age eleven, does Piaget believe they are capable of understanding abstract concepts. It is at this stage that the child is also able to understand that there are multiple outcomes to a situation, and able to understand all the theoretical possibilities (Siegler et al, 2005).

Piaget believed that the child progressed from one stage to the next using the processes of assimilation, accommodation, and equilibration. With assimilation the child transforms all inputs around him/her into a form that fits within their existing level of thinking. For instance, when a very young child learns that a four-legged furry house pet is called a dog, it may initially call all four-legged furry house-pets dogs, much to the distain of the house cat. Then as the child learns that there is a difference in four-legged furry house-pets, it adds this differentiation to it's knowledge. This adaptation to the child's way of thinking is called accommodation. As the child accepts this differentiation between four-legged, furry house-pets, she/he reaches a state where this information is accepted and is now part of his/her knowledge base. Piaget refers to this state as

equilibration. The child has encountered a challenge to his/her knowledge, accepted the new information, and creates a new baseline of his/her knowledge regarding furry, four-legged house-pets. (Siegler et al, 2005)

VYGOTSKY AND SOCIO-CONSTRUCTIVISM

Socrates

I begin this section with a review of Socrates and the Socratic Learning Method as perhaps one of the earliest recorded examples of socio-constructivist learning. In the method, Socrates initiated the students in an exploration of the topic, acting as a facilitator, allowing the students to construct knowledge. I begin with Socrates because I feel that in looking at later literature on Socio-Constructivism, understanding some of the earliest roots of this methodology helps to understand why later proponents were so passionate regarding its success.

Socrates employed a technique now termed the Socratic Learning Method to encourage students to develop meaning and understanding by constantly questioning their preconceptions, asking them to clarify their preconceptions, testing their resultant hypothesis or what propositions they have encountered, and ultimately deciding to accept or reject said hypothesis or propositions (Lam, 2011). Although Socrates himself left no writings, his student, Plato, recorded many such interactions and even alluded to some reasons for the development of this method. Socrates was frustrated with the arrogance of the elite classes of his time and delighted in reducing so-called "learned" men by the use of his questioning method, so much so, that he was forced to issue an apology (Tweed et al, 2002). To challenge this elitism, Plato recorded that Socrates claimed that he could take an uneducated slave boy and by using only his method of questioning, have him construct a complex geometric principle (Tweed et al, 2002). It would seem that

Socrates was motivated by the presumptions of class and the ideals of democracy in the development of his methodology. That is, that all men have equal ability to learn and construct meaning, if given the opportunity.

Socrates decried the now termed "instructivist" (Lam, 2011) form of education, which is the more lecture centric format, as not being a true form of education. He asserted that one cannot simply insert knowledge into a soul like "inserting vision into blind eyes." In his theory, you must involve the whole person, and mind (soul). In his time, Socrates believed that the soul possessed knowledge, but had just simply forgotten it and that by using his questioning method, that knowledge could be re-awakened (Lam, 2011). He postulated that one cannot simply just create knowledge from nothing, that it must be constructed from a combination of input from the environment and what the learner already knows.

Dewey

It is this line of reasoning that lead me to my next influential figure in the evolution of Constructivism, John Dewey. John Dewey, considered by some to be the eminent philosopher of his age, developed distinct views of education and learning that bear resemblance to theories of Socrates as put forth by Plato, Galileo, and the pragmatism of Confucius. For instance, in *Democracy and Education* (1916), Dewey asserts "Education is not an affair of "telling" and being told, but an active and constructive process" in Garrison, 1995, p.43. This would seem to reflect the underlying tenets of the Socratic Learning Method as outlined previously. Galileo also influenced Dewey, by his ideas of experimentation versus qualitative experience in constructing theories and knowledge (Garrison, 1997). Like Socrates, Dewey was influenced by his times. Dewey developed his theories of education at the beginnings of the industrial

revolution. Employers were complaining that potential employees lacked the connection between scholarly knowledge and practical experience (Garrison, 1995). Like Socrates, Dewey rejected the lecture style of education in favor of an involved constructive method. This also bears a resemblance to the Confucian orientation of pragmatism. Confucius believed that an acceptable goal of learning was to be able to benefit society through a role in civil service.

Unlike Socrates, who used questioning to construct knowledge, Dewey advocated for the use of long-term projects to assist the student in constructing new knowledge (Glassman, 2001). It is evident that Dewey, like Socrates, held prior knowledge in high regard. He felt that one of the most important roles of education was to teach children how to maintain relationships between knowledge and experiences so that they could build upon them and constantly add and test new knowledge (Glassman, 2001). Dewey was also influenced by a dislike for social class. He felt that education was to be used in practice, not discussed by the social elite with no practical experience and no need to work or put theory to practice.

In the 1920's, Dewey embarked on several international lecture tours. By this time his publications had been internationally received and his theories were gaining some notice. Interestingly, this coincided with the educational reforms taking place in the new Soviet Russia.

Vygotsky

In Soviet Russia, a young pedagogical philosopher named Vygotsky was gaining popularity and notice. Although there are multiple different opinions on how Vygotsky came to prominence, his work began with "defective" children, those with either mental or physical handicaps. His work drew the attention of high-ranking Minister of Art and

Education, Lunarcharsky. It was Lunacharsky who asked Vygotsky to organize a laboratory for the study of the psychology of the abnormal childhood in 1925. The involvement of another high-ranking person, Deputy Minister N. Krupskaya, resulted in Vygotsky being appointed as a professor at the Second Moscow University and as a co-worker at the Institute of Psychology. It was during this appointment, in 1928, that Vygotsky had the opportunity to meet Dewey when he was invited by the Ministry of Arts and Education to visit Russia (Prawat, 2000).

In 2000, Prawat published an article in which he outlined the probability of a meeting between Dewey and Vygotsky. Prawat used both published and unpublished letters of Dewey at the time, in concert with the diary entries of Elizabeth Dewey, John Dewey's daughter-in-law, who accompanied him on his Russian tour, to construct a detailed recollection of his visit (Prawat, 2000). Many of Dewey's publications to date, including *The School and Society* (1899), had been translated into Russian, and he was well received (Prawat, 2000). Dewey's host in Moscow was Lunarcharsky, who, like Dewey, was a pragmatist. Prawat argued that with the inclusion of the remarks in Dewey's writings and Elizabeth's diary, his relationship with Lunarcharsky, and his visitation to the Second Moscow University, it is unlikely that Dewey did not meet Vygotsky, who spoke fluent English (Prawat, 2000).

Whether or not Dewey influenced Vygotsky, they shared some common ideas in their theories, and some differences. Both Vygotsky and Dewey saw inquiry as based in progressive problem solving, and can be seen as a direct link to the Socratic Method of Inquiry (Glassman, 2001). The similarities in their theories were extensive, but not all encompassing. Where Vygotsky focused on the Zone of Proximal Development, Dewey was in favor of stimulating the student through long-term projects (Glassman, 2001).

Vyotsky's Zone of Proximal Development, or ZPD, was defined by Vyotsky as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). In this theory of development, Vygotsky postulated that development was led by instruction, and that the learner was propelled by, or pulled by an increasing interest in higher problems by the teacher or "more capable peer." It is unfortunate that Vygotsky fell out of favor during Stalin's reign over the USSR. There is much speculation regarding Vygotsky's fall from popularity, from a differing view of the development and purpose of language with Stalin, to a charge of being bourgois. It was not until after Stalin's death that Vygotsky's writings were allowed to be published and read once again. Even then, it was not until the 1962 publication of *Thought and Language* that Vygotsky's theories came to the attention of the west.

Piaget and Vygotsky also had some rather dramatic differences, but also some subtle similarities. I will begin with some higher level differences, then address some similarities. The most glaring difference is the order of development and learning. Piaget believed that development predated learning and that instruction on a level that exceeded the current development cycle would be ineffective. To this end, Piaget detailed four stages of development and the level of learning that could occur within each stage. He also outlined the three processes by which a child could progress from one stage to the next.

Vygotsky, on the other hand, held that learning was the catalyst for development. It was when the child was encouraged beyond his/her current level of development by learning that development could advance. Although later theorists attempted to apply Vygotsky's theory to early childhood development, he felt that the learning that occurred

prior to school-age was very different than the learning in school (Vygotsky, 1978). Instead of detailed stages, Vygotsky focused on what he termed the Zone of Proximal Development. He theorized that this ZPD existed between what the child knew independently, and what the child could accomplish with the assistance of an adult or knowledgeable other (peer) (Vygotsky, 1978). He focused mainly on core academics, whereas Piaget was concerned with all development. Vygotsky was motivated in this direction by the learning goals of his country and the times. In the USSR at that time, the emphasis (according to Leont'ev in Wertsch, 1985) was to estimate a child's capacity, to help them become what they "not yet are." In America, Leont'ev claimed, we were concerned with how the child has become what he is. This small mention underlies, I feel, one of the primary reasons that Vygotsky and Piaget's approaches were so different. Piaget sought to look behind to create a structure for understanding future development and learning, whereas Vygotsky looked only ahead, based on the child's current level.

As different as they were on many levels, they did have some similarities. Both Vygotsky and Piaget shared a definition of internalization. They both held that internalization was that necessary transition when something that a child experiences makes that connection with meaning and becomes understood (learned) on an internal level (Werstch, 1985). However, where Vygotsky focused on the internalization of language and higher mental function, Piaget focused more on representative systems and young children, focusing more on schemata. They also shared the notion of imitation. They both held that imitation allowed children to expand their learning (or development) beyond their current capabilities, either in a collective activity or under adult guidance (Vygotsky, 1978). However perhaps the most interestingly, to me, Vygotsky and Piaget shared the concept of *concreteness* and even shared a definition. They both believed that *concreteness* was a necessary step in development on the way to abstract thought

(Piaget's formal operations period). Piaget saw this as a developmental stage in a child's life, however, and Vygotsky saw it as a "stepping stone" to abstract thinking (Vygotsky, 1978).

With all the commonality in their theories and works, Vygotsky and Piaget never met. Interestingly, Piaget commented in 1962 on his sadness in never meeting or reading Vygotsky's work until that year (Piaget, 1962). This is interesting, but not surprising given that Piaget only published three of his numerous publications before Vygotsky's death and access to Vygotsky's works were not generally available outside of the Soviet Union until after Stalin's death.

How are Vygotsky's and Piaget's theories so central to the constructivist views of learning? There are some who would argue that Vygotsky is not a constructivist due to his emphasis on the social aspect of learning (Sedl, 2013). However at the heart of Vygotsky's learning theory is the Zone of Proximal Development that arguably can be described as a blueprint for constructivism in the classroom. Using another Vygotskian concept, scaffolding, the more knowledgeable other guides the student from a known situation into an unknown situation allowing the student to use prior knowledge to construct a new understanding of the unknown situation. Scaffolding describes the amount of guidance the more knowledgeable other provides to the student as the student progresses to a new understanding. Like the scaffolding supporting a construction project, the more knowledgeable other support the student's progress until he/she is able to form a complete understanding on his/her own. Scaffolding provides a network of support and direction to the student without doing the actual construction. To this end, Vygotsky's theory of the Zone of Proximal Development and the use of scaffolding strongly reinforce the concept of student constructed knowledge emphasized in constructivist learning theory.

Piaget's developmental learning theory, unlike Vygotsky, outlines the cognitive ability of a child from birth to adulthood (Siegler et al, 2005). In this way, Piaget was outlining to the teacher the assumptions that could be made as to the child's ability, and the importance of exploration and play in constructing knowledge about the child's environment. At each developmental stage, the child constructs an understanding of his/her environment and the problems that he/she faces at a particular level. This construction is expanded to higher levels as the child's development allows.

In my analysis of the foundations of constructivism, I have detailed the basic theories of the two main figures in educational constructivism, Vygotsky and Piaget with some reference to Dewey and his contributions and to Socrates. Although many educational theorists have espoused constructivist theories of learning and development, Piaget and Vygotsky are acknowledged by many to be at the heart, the foundation, of modern constructivist learning theory.

Piaget and Vygotsky formed a foundation for modern constructivist theorists. However one of the criticisms of constructivism is that pure discovery based methods can leave a learner frustrated and without context (Mayer, 2004; Sweller, 1999). It has been proposed by several learning and instruction theorists that constructivist learning environments need to be highly structured and to provide a scaffolding for the learner (Jonassen, 1997). This is further reinforced by Kirchner, Swellerr, and Clark in their 2006 paper that questions that there is no "body of research" that suggests that a minimal guidance approach is successful and that a minimal guidance approach can lead to misconceptions or incomplete knowledge.

Chapter 3: Bronfenbrenner's Ecological Theory

In this chapter I will discuss the evolution of Bronfenbrenner's Ecological theory, what may have influenced Bronfrenbrenner to propose the theory, and the ultimate iteration of the theory.

Bronfenbrenner was born in 1917 in Russia but moved to the United States at a young age. He attended Cornell University and completed a double major in psychology and music in 1938, and then went on to complete a masters degree at Harvard in developmental psychology and a Ph.D. from the University of Michigan in 1942, a time when the United States had just entered World War II

In 1943-1944, Bonfenbrenner published a two part paper, entitled "A Constant Frame of Reference for Sociometric Research." In this paper, he emphasized a need for consistent techniques for gathering sociometic data and that this must include not only data on the individual, but on any social organization of which the individual is a part (Bronfenbrenner, 1943). In the second part of this paper, Bronfenbrenner (1944) advocated longitudinal studies that involved not only the individual, but their environment and how both are changing with time, and how they affect each other. Although it is interesting to read and understand the failings of standard statistical research methods in the socio-cultural realm, it is beyond the scope of this paper. However, within the paper, one can begin to see the roots of what would become Bronfenbrenner's Ecological Learning Theory.

Although there is no documented rationale about how Bronfenbrenner became interested in accurately measuring sociometric data, one can draw correlations to his time spent in the military, specifically in the OSS, where such information was of strategic

importance, He understood the wide consequences of decisions that were made that utilized conclusions drawn from such data.

He continued to explore the process by which sociometic data were gathered, analyzed, and utilized. In 1952, he and Edward Deveraux published a paper on Interdisciplinary Planning for Team Research on Constructive Community Behavior The Springdale Project. Although the central theme of the paper was the trials and tribulations of a cross-disciplinary team project, his emphasis in considering the whole system, as well as the individuals involved, was evident.

In the late 1950's, Bronfenbrenner began a program of research that focused on parental roles and personality development (Bronfenbrenner, 1960). He began by consolidating existing theories regarding development and personality by Freud and expressed exasperation that existing theories had grown out of proportion to the facts. It is here that he expressed his concern that no one had yet attempted to investigate empirically how or why a child develops. I see that it is in this paper that Bronfenbrenner sewed the seeds for the direction of his future research, as was his intent, that culminated in his Ecological Theory. Not to forget his concern for accurate data and appropriate conclusions, Bronfenbrenner wrote in 1974 of the importance of vitality and validity in the social sciences. It was Bronfenbrenner's observation that when public policy is driven by social science data, those data need to be accurate and provide "truth," as was asked for by the policy makers. Too often, Bronfenbrenner found himself in the position of providing "wisdom", but with little data to reinforce his statements (Bronfenbrenner, 1974). Of interest in this paper is that Bronenbrenner mentioned the importance of the child's ecology, his term for the context or environment in which a child develops. He went on to outline the various layers of this ecology. In conclusion he declared his intent to develop this theory in the immediate future so that human development could be

studied and measured "in context" and to provide research that possessed both rigor and relevance (Bronfenbrenner, 1974).

It comes as no surprise to see that in 1977 Bronfenbrenner published a paper entitled "Toward an Experimental Ecology of Human Development." In this paper, he married his earlier focus on accuracy and context sensitive data to his theory about how a child's environment affects them and how they affect it (Bronfenbrenner, 1977). He announced that his theory of experimental human ecology was a change in direction for research and theory in socialization, and here we see the use of the terms that became the standard for his model: *microsystem, mesosystem, exosystem* and *macrosystem*. He connected his theory to that of Kurt Lewin. Lewin, a prominent social psychologist, proposed that both nature and nurture interact to form an individual ("Kurt Lewin", 2013). I mark this paper as the beginning of Bronfenbrenner's publications regarding a cohesive theory of development and learning, one that includes the ecological environment as a nested arrangement of structures and that defines what an ecological experiment is and what validity consists of in this context.

It is in 1979 that Bronfenbrenner put his theory into form in a book entitled *"Ecology of Human Development: Experiments by Nature and Design"*. In this text, he put forward descriptions of the various levels of his ecological theory.

Bronfenbrenner (1979) defined his ecology of human development as the "progressive, mutual accommodation between an active, growing human being and the changing properties of the immediate settings in which the developing person lives, as this process is affected by relations between these settings, and by the larger contexts in which the settings are embedded" (p.40). Bronfenbrenner's model incorporates not only the developing child, but also the environment in which the child finds himself/herself,

it's effect on the child, the child's effect on the environment, and how the different aspects of the environment affect each other.

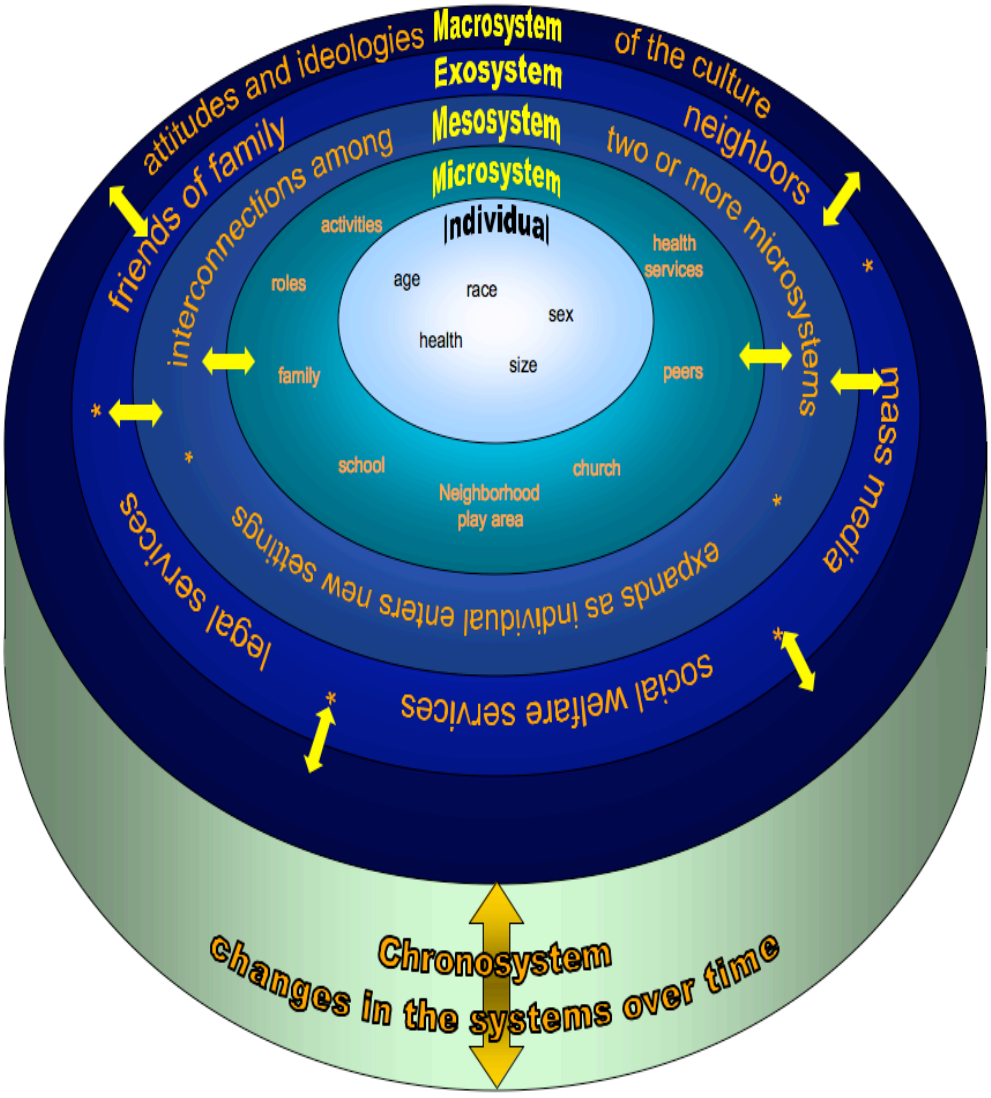

Figure 2: Bronfenbrenner's Ecological Model

In Bronfenbrenner's model, the innermost aspect of learning is the microsystem. At this level, the child's interrelations within his/her immediate

environment is analyzed. The microsystem includes all that which immediately affects the child, such as the people or objects with which the child can readily interact. Bronfenbrenner credited Piaget, specifically his publication of "The construction of reality in the child" (Piaget, 1954), for some of the structure within the microsystem. However, he also emphasized the differences. Unlike Piaget, who took the child out of his/her context, Bronfenbrenner's theory highlighted how a child's awareness and involvement with his/her environment expands his/her perceived reality (Bronfenbrenner, 1979). Bronfenbrenner's theory includes Piaget's concept of perceptual constancy, and his realization of the relations between events in different setting. However Ecological Theory includes the effects of the child's immediate setting and interactions. Bronfenbrenner asserted that as the child matures, his or her awareness of the outer systems of influence, meso-, exo- and macro-systems, increases, as well as the child's effect on those systems and their effect on the child (Bronfenbrenner, 1979).

The mesosystem is the next layer in Bronfenbrenner's expanding model. As the child matures, he/she progresses to understanding interactions at this level with two or more settings in what Bronfenbrenner termed *social networks*. At this level of development, the child begins to understand his/her place in a larger setting, including school or daycare. As the child matures, she/he develops communication skills for this level and information and knowledge are obtained through communication or interactions between child and environment (Bronfenbrenner, 1979).

Next, the child progresses to understanding his or her place in the exosystem. At this level, the child may or may not affect the surroundings, but is surely affected by them. This level includes interactions with extended family, the effects of parent's workplaces and their friends, and mass media. Although the child, by himself/herself, cannot affect much on this level, like the content of mass media, he or she can be

profoundly affected by it. Children can gain knowledge of the various elements in their lives at this level and begin to understand what they can and cannot control. At this level they learn that although they may not be able directly to affect elements at this level, they can begin to understand how these elements affect them, and they can begin to choose, as they learn, what they can allow to affect them, where such choice is possible (Bronfenbrenner, 1979).

Finally, the child reaches the developmental level of the macrosystem where he/she can begin to understand how culture, social class, and ideologies affect him/her. It is at this level that children can begin to understand the world and their place in it. The longer the child is at this level of development, the more he/she understands the elements of the previous levels that were governed by this level and how these levels affected his/her development (Bronfenbrenner, 1979).

In 1997, Bronfenbrenner described a new, 5th level to his expanding ecological development model, the chronosystem. The chronosystem is not so simple as another layer in the nested systems of the model to this point, but represents changes to each system over time, such as the changing relationships between a child and a primary caregiver over time when the child becomes less and less dependent and the caregiver becomes less centered on the child. Bronfenbrenner used a study done on children in the Great Depression (Elder, 1974) as his example of how changes over time intersect with the other layers. In this study, children who were adolescents at the time and whose families had suffered economic loss were compared to those adolescents whose families had not suffered loss. This change in their environment changed the child's developmental systems and their interrelations within the systems. Elder hypothesized that because the children of deprived families had to pull together to survive, this changed the roles of these children and changed their levels of responsibility and

ultimately their understanding of roles and responsibilities within the system structure (Elder, 1974).

It is considered that the model that Bronfenbrenner published in 1994 was the "mature" form of his model (Tudge, Mokrova, Hatfield, & Karnik, 2009), although these authors acknowledged that such models continue to evolve through time. According to Tudge et al., it was in the 1990's that Bronfenbrenner began to use the term "Process-Person-Context-Time" to describe the essence of his model. In 1998, Bronfenbrenner teamed with Morris and published an interesting view of the importance of processes and how they become increasingly more complex as the child progresses through the layers of systems. They referred to the processes as "complex reciprocal interactions" between the developing child and their environment (Bronfenbrenner & Morris, 1998)

As Tudge et al. (2009) pointed out, one of the major ways that Bronfenbrenner's theory can be misunderstood is in the chronosystem. To see accurately the effect of time on the interactions that make up the different systems, the study must, almost without fail, be longitudinal. Another misuse of Bronfenbrenner's theory was with experimenters ignoring what was termed *proximal processes*. Proximal processes are interactions that are in the immediate environment and have direct measurable affect on the child and can be reciprocal, as opposed to processes that are more distal and do not affect the child as directly, and that the child cannot affect (Bronfenbrenner & Morris, 1998).

Bronfenbrenner drew upon the constructivist theories of both Piaget (1964) and Vygotsky (1978), but expanded both of their theories beyond the direct influences on the child. Like Piaget, he believed that children's understanding of themselves and their abilities evolved over time, but like Vygotsky, he believed that the children's environment and their interactions with others played an influential and crucial role in development. His model is much more complex than either Vygotsky's theory or

Piaget's developmental model, and leads to a discussion of an attempt at an all-encompassing model of learning. In the next chapter, I will discuss chaos theory, and offer such a complexity model as a possible next step in the evolution of theories of development.

Chapter 4: Chaos Theory

In this section, I explore the origins of Chaos Theory, its implications in science, its growth as a popular concept, and its transition into a general theory for all systems, including education. I will also note the pitfalls of chaos theory, and those educational theorists that are both proponents and opponents. Finally, I will provide my understanding of the best use of chaos theory in education as a segue into the final section of this paper.

Chaos Theory, or as is was originally known, Dynamical Systems Theory was first proposed by Poincare in a series of papers written from 1881 to 1886 (Ding, Grebogi, & Yorke, 1997). Poincare's observation was that small differences in initial conditions can cause enormous differences in the final result. His work, mainly considered more theoretical than experimental, was largely ignored until the 1960's when a wide variety of chaotic systems known as Anosov Systems were observed and published (Ding et al., 1997). In the 1970's there were several important scientific papers published concerning dynamical systems, chaos theory, concerning the physical sciences and computing (Ding, et al., 1997). However, it was not until the 1980's that a bridge between experimentalists and theorists was forged.

The application of theoretical views to experimental work led to the examination of non-linear systems, chaos theory, in connection with the study of the human brain. Chaos theory has since been applied to many concepts such as politics, global warming, mathematical modeling of ozone depletion, and other dynamic systems with virtually incalculable numbers of variables (Campbell & Mayer-Kress, 1997). Much of what is today popularly understood of chaos theory is called the Butterfly Effect as conceived by

Lorenz in 1972 (Lorenz, 2000). In essence, the explanation of a dynamical system was relayed by the story of a butterfly flapping its wings in Japan causing a hurricane in the Atlantic. This story has been told and re-told many times, with the location of both the butterfly and the ending storm changing, but with the concept remaining: a minute change in an initial condition can cause dramatic changes in the end event.

In Figure 3, G. Mayer-Kress uses chaos theory to map the effects and subsystems of global environmental change, illustrating the complex and dynamic relationships within a chaotic system.

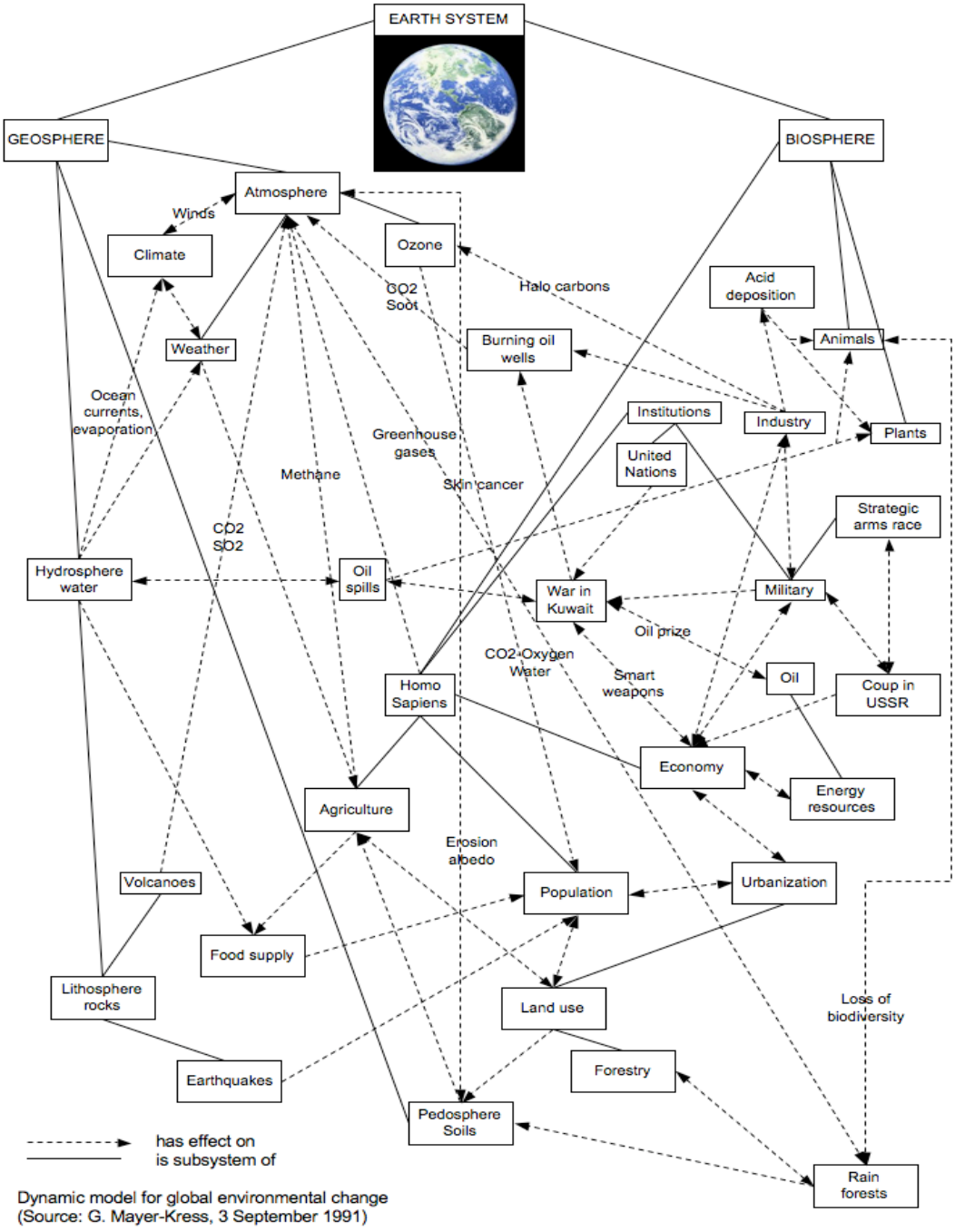

Figure 3: Dynamic Model for Global Environmental Change (Campbell et al., 1997)

However, with this conclusion came the realization that the effort that it takes to expand on data collection and computer simulation grows exponentially, and so the greater the number of variables being considered, the slower and potentially less useful the conclusions. This is particularly relevant for the accurate determination of short-term predictions regarding complex systems that appear to behave completely randomly (Campbell et al., 1997).

The question that naturally arises is how this concept can help us understand learning.

Chaos theory can apply both to what I am terming the *inner world*, and the *outer world*. The outer world is every piece of information and knowledge that exists outside of ourselves, and the inner world is what we know and understand. In my consideration of the application of chaos theory as a learning theory, I have explored both.

Another theory that explores the utility of chaos theory is *connectivism*. Siemens (2004) defined *connectivism* as "the integration of principles explored by chaos, network, and complexity and self-organization theories. In *connectivism* learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning can reside outside of ourselves, is focused on connected specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing." In his interpretation, chaos theory recognizes the connection of everything (outside the self) to everything else, and thus everything is connected.

Internally, dependence on initial conditions profoundly influences what a person learns and how a person acts based on his/her learning (Gleick, 1987). Gleick compared *constructivism* with *chaos* by observing that in constructivism, learners are said to learn by making meaning, whereas in chaos theory, meaning is said already to exist, and the

learner's challenge is to recognize the patterns and connections that may be hidden or not obvious (Gleick, 1987).

In the 1990's, there were several articles that applied chaos theory to explanations of learning. In 1991, Rockier asserted that current forms of education were linear, based on behavioristic methodologies that produced and required predictable responses. In turn, educators use these predictable responses to train the student. Rockier's concerns were well founded with the then current initiation of widespread standardized testing. To Rockier, it seemed as if educators, and those concerned with educational results, were confusing these conditioned responses with learning. In this same time period, MacPherson made a case for rejecting what he saw as the deterministic cause and effect reasoning prevalent in education, arguing for a more chaotic reasoning (MacPherson, 1995).

However, there were some very valid arguments against the use, or what was described as *misuse* of chaos theory to represent learning. In 2010, Hunter stated that although MacPherson's theory was comprehensive, he seemed to imply that one could apply a theory concerning weather system to education. Hunter argued that applying chaos theory to education seemed to preclude the possibility of choice or "willful" actions by human beings.

Several authors have used dynamic systems theory in their discussions regarding development. Van Geert (2000) proposed that within the dynamic model there are two mechanisms that drive change. Derived from concepts proposed by Piaget and by Vygotsky, first there is the conservative force that strengthens the existing relationships between systems. Secondly, there is the progressive force. It is the progressive force that drives the emergence of new systems and new relationships between systems.

It must be understood that dynamic systems are complex and do not follow the linear model of cause and effect (Fogel, 2011; Thelen & Bates, 2003). Dynamic modeling is only possible as a result of a stabilization of complex systems. Over time, complex systems organize and reorganize into a series of dynamically stable patterns (Fogel, 2011). It is this relative stability that allows models such as mine to use Chaos theory as a mechanism for understanding learning.

In my own developing understanding of learning, I am proposing to use chaos theory to model how a student understand and assimilates knowledge. Each student is, in himself/herself a dynamic system. What the student absorbs, how the student absorbs and processes, and how he/she fits this new information fits into the existing knowledge matrix is different for each student and can be influenced by minute differences in initial conditions. Some conditions are internal, such as mood, pre-existing knowledge or experiences, or interest. Some conditions are external, such as comfort level, mode of information presentation, general classroom culture, or instructor mood. It is in this context that I wish to explore chaos theory as a way of understanding learning, and if understood, a theory for teaching in such a dynamic system. In response to Hunter's (2010) assertion that chaos theory ignores the willful actions of the human being, I would like to propose that such willful actions are part of the internal chaotic system.

However, I recognize that there is a law of diminishing returns involved with this approach. Educators must understand that the initial conditions for each student each minute of each day are as numerous as the stars, and each cannot be accounted for or anticipated. Indeed, the more a teacher attempts to compensate for or understand each difference, the less effective the teacher may be at teaching the whole. So, understanding this pitfall of chaos theory in this context, seeing each student as a dynamical system, educators must try to identify the main contributing variables, as some variables will have

a greater effect on most students' learning than others, and teachers must accommodate these variables to the best of their ability.

Chapter 5: Synthesis

In this chapter, I will present a synthesis in the form of a theory incorporating elements of theories presented previously in this report. Although chaos theory offers a comprehensive approach to understanding how and why children learn the way they do, the complexity of the theory and the infinite multitude of variables make it a formidable and, perhaps impossible, theory to use in a practical sense. Chaos theory can explain how one thing is connected to another, saying in essence that all things are connected at some level. I postulate that chaos theory can explain how one approach may work for some students, who have a sufficient amount of pre-existing variables in common for the approach to be synthesized, while other, apparently similar students do not grasp the concept. Similarly, I analyzed the theories of Constructivism and Bronfenbrenner's Ecological model, and together with chaos theory, saw them in order of levels of abstraction. I found that combining the idea of sociocultral concepts with Bronfenbrenner's Ecological model brought me closer to my goal of understanding the common threads that can be a basis for meta-knowledge and the commonalities that can be used to teach children effectively. I found, however, that Bronfenbrenner's model, while comprehensive, was too constricting. In an attempt to broaden its scope, I have adapted the concept of Meyer-Kress's Dynamic Model for Global Climate Change, in combination with Bronfenbrenner's concept of a chronosphere, but using the chronological structure of an American public school stages as a foundation for what I offer as a comprehensive model of the variables that affect a child's learning at various stages.

Five stages are mapped individually, by age groups, using the concept of the Dynamic Model. Key in building this model was identifying the most common parts to the dynamic model to use as variables. By reducing the variance of these variables that affect child learning, I hoped to protray an environment where the initial conditions affecting a child's encounter with new information are better understood, and one can hope to help more children learn in a group setting effectively.

In the following five graphic models, the dotted lines with arrows emanating from the child to a system denote an interaction of the child with the variable. Dotted lines with arrows on both ends indicate that the child is not only interacting with the system, but cognizant of its effect. For example, an arrow going from the child to younger sister but not going back indicates that at this stage of development, the child is interacting with the younger sister, but not cognizant of how the younger sister is affecting him/her. These arrows can be approximately associated with Bronfenbrenner's model at the mesosystem level, illustrating the relationships between systems, but confined to the child'sperceptions. Following each graphical representation, I will explain the various relationships between the systems represented.

In the interest of making this model simple enough to be easily understood, I have made several assumptions regarding the modeled individual. I assume a middle class, American upbringing within a household consisting of a mother and father (not necessarily biological, but ever-present), extended family, gainful employment, at least some level of post-secondary education, and some level of financial security that would allow the exploration of issues other than subsistence. I also assume a middle class neighborhood and only minimal concerns of crime and do not include illicit drug or alcohol use in my model. These exclusions do not come from naïveté but from a desire

to limit the model to an understandable level. The model would need to be altered for different situations, different socio-economic levels, and cultural differences.

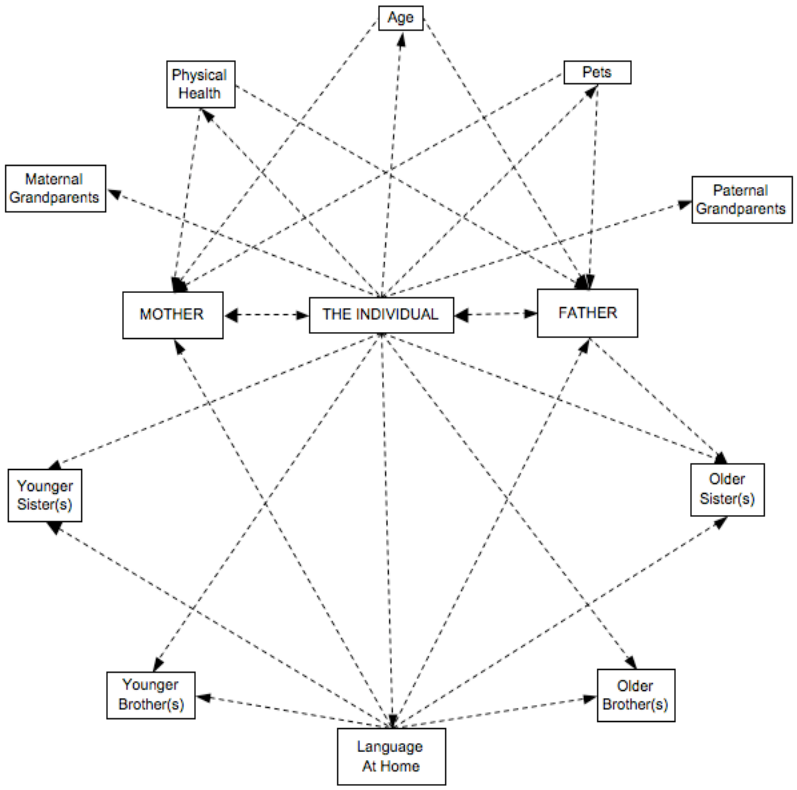

Figure 4: Dynamic Model for an Individual's Perception of the Variables in Their Lives – Infancy (Birth to approximately 18 months old)

INFANCY

In Figure 4, as with all five levels of the model, in the center is the child. In this case, the child represents a child in infancy. The other boxes represent those elements (Bronfenbrenner would call them *systems*) that the infant may interact with as part of the world. The arrows emitting from the child going to maternal and paternal grandparents, pets, older brother(s) and sister(s), and younger brother(s) and sister(s) indicate that at this level, infancy, the child is interacting with these other systems. The lack of a return

arrow indicates that the infant is not cognizant of his/her effect on the system, that is, how he/she can affect grandparents, siblings, or pets or how the system can affect the child.

Arrows emitting from the child to concepts such as physical health, age, and language at home indicate that the infant is interacting with these concepts. In the case of physical health, the infant is interacting with the concept of health, even if only on a primitive good-bad dichotomy. Arrows then going from the physical health system to the mother and father systems indicate that the infant is cognizant that his/her health affects mother and father, even though this may be very basic. The arrow illustrating an interaction with the concept of age is even more vague. The infant may not be cognizant that he/she is aging directly, but at some level may recognize that he/she can do more each day, such as sitting up, eating solid foods and walking, and in turn, may recognize that interacting with these systems affects mother and father, as denoted by the arrow going from age to those systems.

Then there is the system of language at home. Language acquisition begins very young, and the infant is interacting with the concept of language as represented in the home. Whether this language differs from that spoken outside the home, the infant may or may not recognize, and it is not mentioned in this stage. When the infant begins to respond to this language, and even begins to make verbalizations corresponding to this language, he/she may recognize the language's effect on other siblings, and on mother and father systems, thus the arrow progressing from the language at home system to these systems.

Then there are the systems of mother and father. The arrows that connect these systems to the child, the infant, are double ended. This suggests that, not only is the infant interacting with his/her parents, but also is developing a cognition of the effect that

he/she can have on the parents. Again, this may be, initially, a very primitive response, but develops as the infant's desire and ability for communication increases.

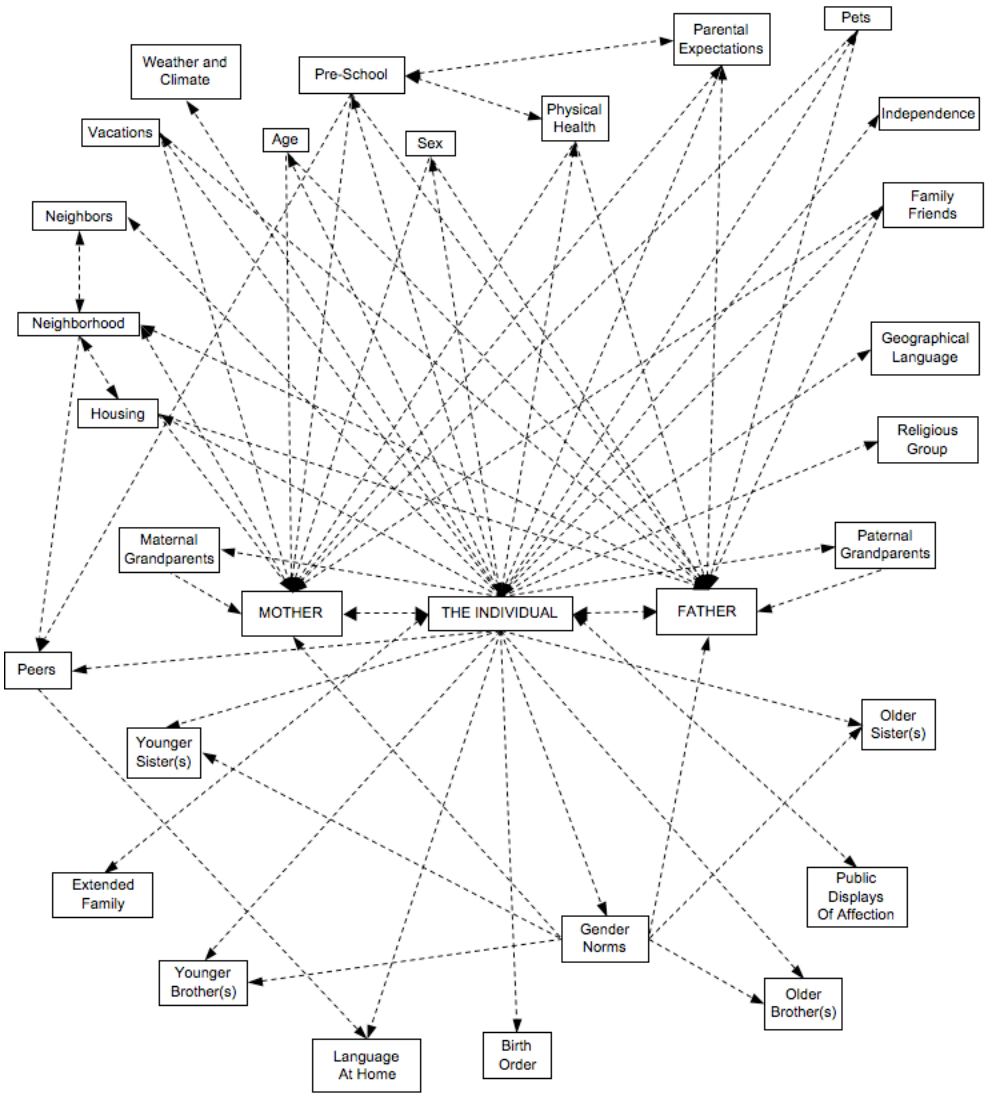

Figure 5: Dynamic Model for an Individual's Perception of the Variables in Their Lives – Pre-School (Approximate Age 18 months to 5 years)

PRE-SCHOOL

In this second level of my model (see Figure 5), the child has progressed to a level I have labeled "Pre-School." Pre-School for the purposes of this paper is defined as a child aged 18 months to 5 years. Included in the pre-existing assumptions mentioned in my introduction, I would like to add that we could assume the child is progressing normally, with no significant physical or mental handicaps. Interrelations between the parents are presumed, as will be true at all levels of this model, to be constant.

As in the infancy model, the pre-school model shows the interaction of the child with the systems that make up his/her world. In this second stage, more of these systems are present in the child's universe. The child continues to interact with immediate family, siblings, and parents, but is now also increasingly interacting with grandparents, peers, family friends, and extended family. The child's interactions begin to extend beyond the one-way relationship into an understanding of how some systems interact with each other and how the child can affect some systems. In some instances, this understanding is becoming part of how the system affects the child.

In the relationship with the grandparents, there is now an arrow that extends from maternal grandparents to the mother, and from paternal grandparents to the father. This implies that the child, aside from just interacting with grandparents, is also now beginning to recognize that grandparents have an effect on the corresponding parent. Similarly, in the relationship with peers, the child knows, even if only vaguely, that peers exist, and the arrows coming from neighborhood and pre-school indicate that the child identifies a relationship between those systems, that basically his/her peers come from either the neighborhood or pre-school. The arrow going from peers to language at home represents that the child recognizes that peers communicate in his/her primary language spoken in the home. Another addition to this level is the arrow from the child to family

friends. This arrow acknowledges that the child recognizes family friends, and arrows tracking from family friends to mother and father indicate that the child is developing an understanding of how family friends affect mother and/or father.

Next, I would like to discuss the child's increasing understanding of concepts such as birth order, gender norms, independence, public displays of affection, and parental expectations. Arrows from the child to each of these concepts indicates an initial and increasing interaction with these concepts. With public displays of affection, the child also is beginning to understand the concept's effect on himself/herself, as indicated by the arrow from the system of public displays of affection to the child. In the case of birth order, independence, and public displays of affection, the relationship ends at this stage with this new interaction. In the case of parental expectations, the child is not only interacting with this concept, but also how the concept affects his/her parents, and how it relates to pre-school. The child is also beginning to recognize the concept of gender norms. The arrows emanating from the concept of gender norms to siblings and parents indicate a growing recognition of feminine and masculine traits, behaviors, and tasks that are different between the boys (men) and girls (women). The child may begin using his/her basic understanding of these differences to form a rudimentary picture of himself/herself and place in the larger system.

The child is also increasing his/her understanding of the constructs of weather and climate, religious groups, and geographical language. Now that the child's world has expanded beyond the home and immediate relations, he/she has begun to recognize that there may be a geographical language; a language spoken commonly in the geographic region where the family lives that may differ from that language spoken at home. The child may also become aware of religious groups with which the family is interacting,

and the effects of weather and climate on the child. Interaction with these constructs may be superficial, but will grow into cognition and connect with other systems in later stages.

Interacting with the systems of pets, age, sex and physical health has expanded, and now include a beginning of an understanding of the effect of these variables on the mother and father. The child is beginning to understand the effect that pets, the child's age, sex and physical health have on his/her parents. Some of this cognition may have begun prior to this stage, but it is progressing to a deeper understanding as time goes on.

The system of pre-school enters at this stage and has a profound effect on the child. It is through the pre-school context that the child may encounter the concepts of geographical language, parental expectations, and peers beyond the confines of the neighborhood. The child interacts with the system of pre-school, but may not recognize on how much it affects him/her. The child is, however, beginning to observe how interaction with the pre-school system affects mother and father, and how the pre-school links to peer involvement.

Next, the concepts of neighbors, neighborhoods, and housing are examined. At this stage, the child is interacting with neighbors in the neighborhood, and by association with these systems, beginning to be cognizant of his/her own housing, and how it is different or the same. The child may even begin to understand that neighbors live in the neighborhood, and that his/her house is in a neighborhood and how that affects his/her parents and peers. The arrows between neighbors and neighborhoods, neighborhoods and housing, neighborhoods and peers, and neighborhoods and mother and father indicate this relationship between the systems.

Lastly, the concept of vacations is introduced. It is at this age group that children begin to recognize the concept of a vacation. The arrow going from the individual to the

concept of vacations represents this. The child may also see the effect that the vacation has on the mother and father.

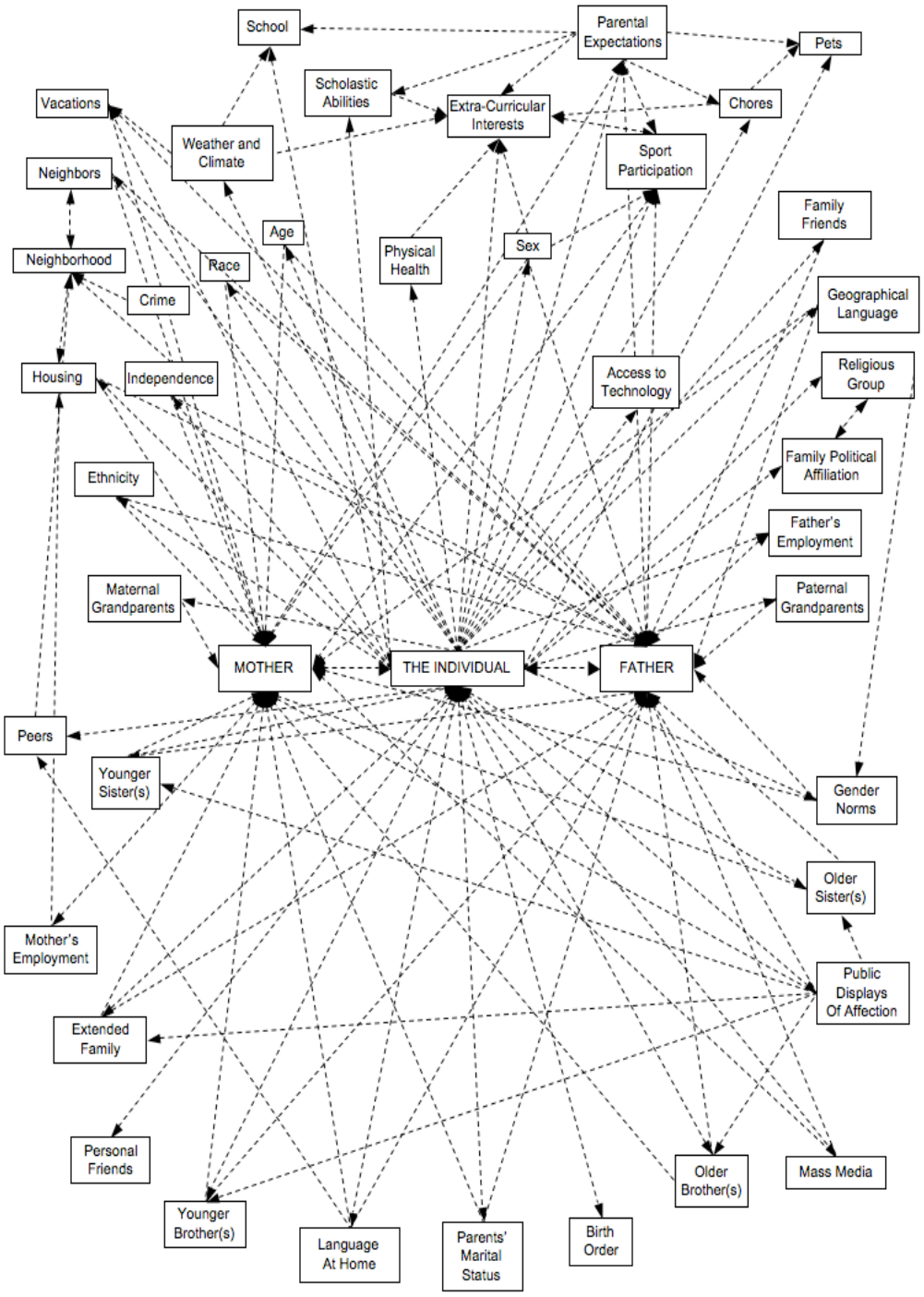

Figure 6: Dynamic Model for an Individual's Perception of the Variables in Their Lives – Elementary School (Approximately 5 to 10 years)

ELEMENTARY SCHOOL

In this stage (see Figure 6), the child has progressed to public elementary school. The world has expanded yet again and grown to include a more dynamic set of systems. The child's interactions have also increased to include not only direct interactions, but a beginning understanding of how systems affect each other.

For instance, the child is now not only interacting with his/her siblings, but is beginning to become cognizant of how his/her siblings affect mother and father. The child is also beginning to understand that the concepts of gender norms, public displays of affection, and mass media affect not only himself/herself but also siblings and parents. At this time, the child recognizes parental employment, although he/she may not understand why it is important. Some awareness of the relationship between employment and housing circumstances may be awakened as a result of having a mother who works and observing peers or friends who have stay-at-home mothers or parental unemployment.

Some relationships may not change, such as the interactions with grandparents and the understanding of the effect grandparents have on parents. The recognition of age and that system's effect on parents, sex, family friends, gender norms, and birth order continues to grow but the full implications of cognition are not yet achieved. The child's understanding of the interactions among these systems and their effects back on the child and others may grow in depth and complexity not shown in this model.

There are many systems with which the child at the pre-school level was already interacting at a basic level. Now the child's interactions have increased to include an understanding of the effect that these systems have on other systems as well as on himself/herself. Independence, neighbors, school (replacing pre-school), geographical language, and extended family interactions have all increased to include how these

systems not only affect the child but the parents as well. The interactions of weather and climate, physical health, sex, parental expectations, and family political affiliations have grown to include how these systems can affect, or interrelate with, other systems, such as extra-curricular interests, sports participation, and religious groups.

There are a number of new systems with which the child has begun to interact. Race, crime, scholastic abilities, extra-curricular interests, sports participation, parental expectations, chores, access to technology, and ethnicity, are new systems that have entered the child's world. One can speculate that these new systems are now part of the child's interactions due to any number of factors but attending public school can be a major source of these new systems. The child is now interacting with these new systems, and in some cases, such as race, sports participation, parental expectations, ethnicity, and chores, is becoming cognizant of how these systems can affect his/her parents. In cases of scholastic abilities, chores, and parental expectations, the child is cognizant of them but may or may not see a direct relationship to the parents.

The model presented should not be considered a model for day 1 of kindergarten but as a representation of the possible systems that grow to affect the child during this elementary school period.

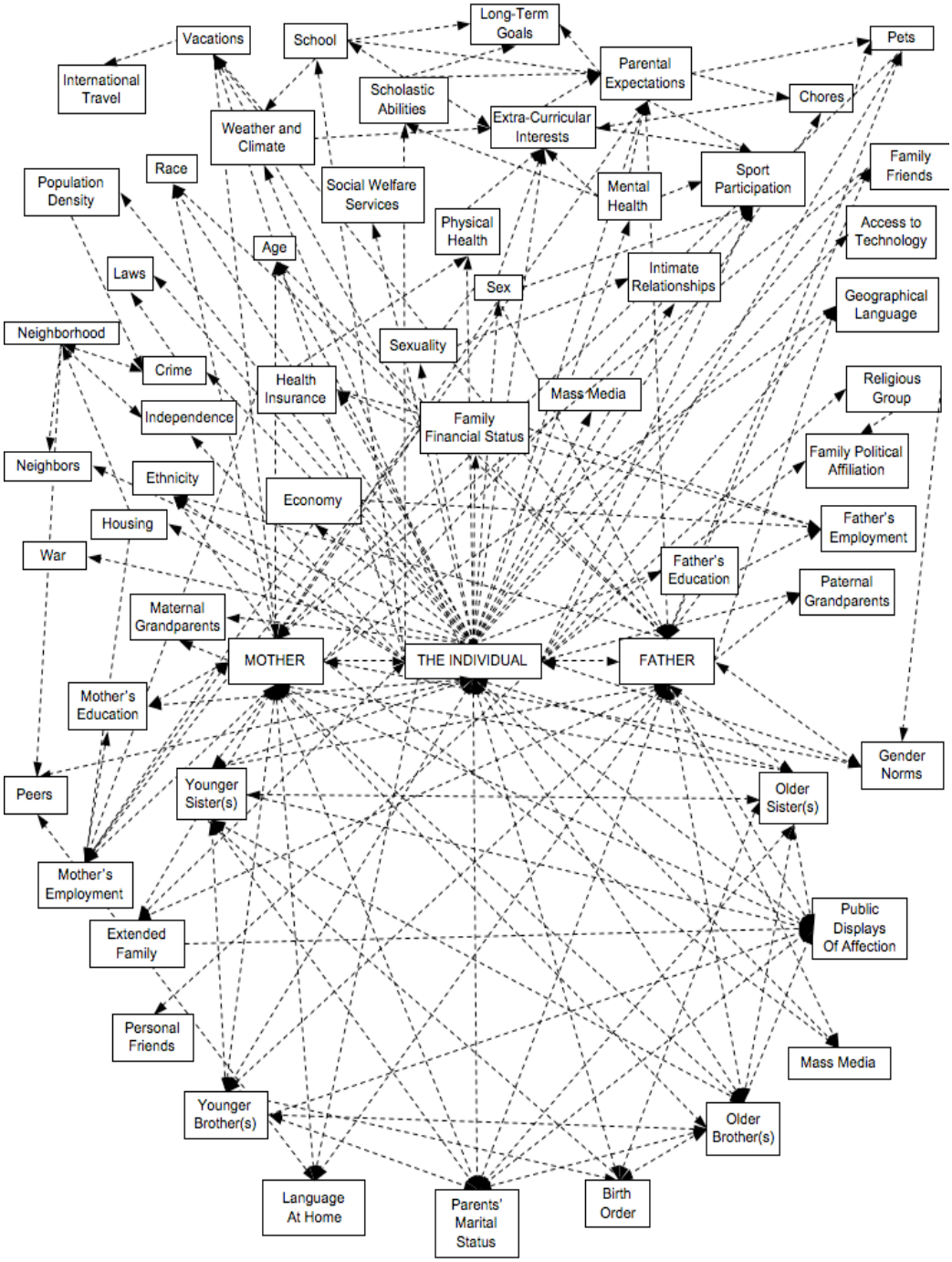

Figure 7: Dynamic Model for an Individual's Perception of the Variables in Their Lives – Middle School (Approximately 11 to 14 years)

MIDDLE SCHOOL

The transition from elementary school to middle school is largely regarded as one of the major milestones of any young person's life. This is easily illustrated by the complexity of the model of systems I have presented for this stage. This model, like the others, is based on the previously stated assumptions of middle class, western, children in a suburban setting with working parents, a two-parent household, and financial security, who attends a public school.

In this section, I will highlight the changes that have occurred from the previous stage, including new systems, and greater awareness of the interrelationships among previous systems.

As the child has aged, he/she is now more cognizant of the interplay between and within his/her immediate family group. Whereas before the child may have recognized birth order, he/she now can begin to understand how this affects siblings and parents. The child can also understand how siblings affect one another, and how parents' marital status affects the entire family unit. A greater understanding of the significance of, or perhaps a shunning of, public display of affection amongst family is also achieved.

The child now can also begin to understand better some systems, such as parental employment, by the introduction of the new systems of mother and father's education. The student may also begin to understand how his/her independence can be linked to the neighborhood. At this time, the child is becoming more cognizant of the family financial status, the systems of health insurance, and social welfare services. Although the child many not understand these systems in depth, interaction with other individuals from school and the neighborhood and a widening of the circle of friends, and the influence of mass media, has had the effect of adding these systems and some basic interactions to the child's world.

These influences may also have added the systems of the economy and war to the child's perception. Depending on the depth of the influence, the child may also develop a basic understanding of how the economy can affect parental employment. The child may also develop a basic understanding of laws and population density, and how these relate to crime and the child's neighborhood. The child's interaction with the vacation concept may also expand to include exposure to the diverse places that one can visit on vacation, including international destinations. The scope of a child's imagination can expand to include exotic and far away destinations.

The system of long-term goals is added, probably with the encouragement of school and parents combined, and is developed by the student in this time frame. Chores reach a new level of interaction as they are tied to extra-curricular interests. The system of mental health enters the student's world and its interaction with scholastic and physical activities.

Lastly, it is in these years that the child begins to explore his/her sexuality, and begins to understand the basics of intimate relationships. This understanding is new, and limited to the immediate effects on the child. The child does not contemplate with any depth how this new system is affecting others, such as the parents.

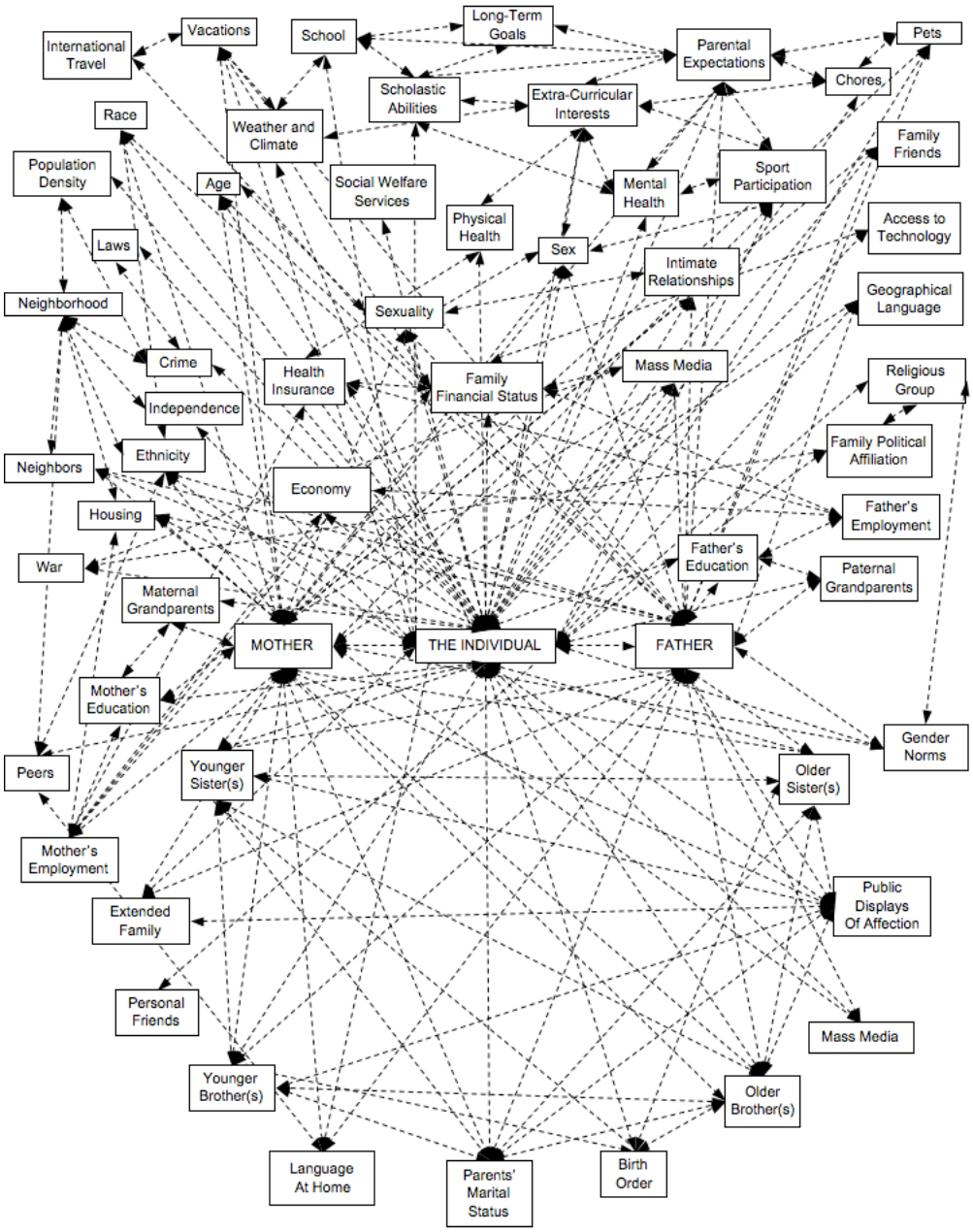

Figure 8: Dynamic Model for an Individual's Perception of the Variables in Their Lives – Elementary School (Approximately 15 to 19 years)

HIGH SCHOOL

Many students see entry into high school (see Figure 8) as the beginning of the road to adulthood. Grades now impact college plans and can directly impact future job prospects, salary, and social status. Relationships become more meaningful and serious, with thoughts of family, marriage, and independence never far. In this model, I chose to keep many systems as they were, following the assumption that these understandings and interactions would only deepen, with only a few new interactions introduced.

Among these new relationships would be the growing understanding that intimate relationships now affect parents, as does sexuality. The child becomes more cognizant that access to technology, mass media, and international travel are associated with, and affected by family financial status. Beyond the immediate family, the role of ethnicity is increased with a better understanding of how ethnicity affects peers. The child also begins to understand the relationship between ethnicity and the neighborhood. Also introduced is a more detailed understanding of the relationship between the economy, war, and the family's political affiliation, as well as an understanding of the relationship between the economy and parental employment.

Most arrows now denote a growing awareness by going both ways, illustrating a growing understanding, not only of the system, but also of how the system affects the child. Also, arrows between systems show a secondary understanding of how these systems interact. No system, except for pre-school, has dropped out of the greater model. Systems have only been added as the world around the child has expanded and become more detailed.

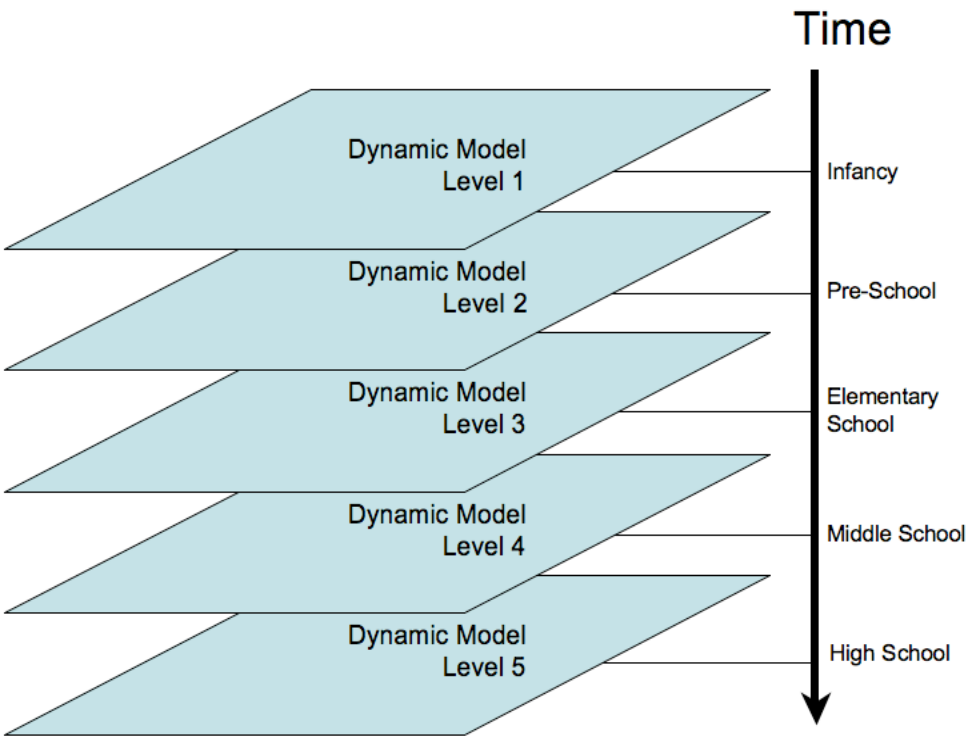

Figure 9: Dynamic Model for an Individual's Perception of the Variables in Their Lives – Elementary School (Approximately 5 to 10 years)

In Figure 9, I have endeavored to show how the previous five stages should be viewed, as a three-dimensional progression from birth through the high school years. At each level, the relationships expand and new systems are added. Arrows from each level could also be drawn to the next, as the child becomes aware of the future implications of some relationships.

CONCLUSION

My models of the dynamic system of the child at each stage of schooling are not all encompassing and undoubtedly show a bias toward American culture and ideologies. It is my intent that this be used as a guide to develop more specific models to allow educators to understand better their populations and to tailor curriculum content and teaching in such a way as to take advantage of the most prevalent commonalities and differences within the dynamic groupings.

This model may also be expanded to include stages in life that are beyond high school, such as college, marriage, having children, and retirement. This could be useful in planning adult education, career counseling, and other adult guidance. However, because I was primarily concerned with the education of children in this report, my focus ended at high school graduation.

The model may also be expanded to include colored arrows indicating the strength of the understanding the child has for a system and the strength of the understanding the child has of the system's effect on other systems. Bronfenbrenner's Ecological Model claims that, even at infancy, the child is influenced by several layers of systems, if for no other reason than the child's parents are influenced by all of these other layers, as in the neighborhood, etc. Thus I could have shown all of the systems present in my final High School level even for the child at the infancy level. Perhaps one way to reconcile my model with Bronfenbrenner's would be to show the systems at every level but to let the arrows between the systems differ. Thus my model might be altered to show all the systems present, but with the arrows as I have modeled them currently to enforce the point that those systems are influencing the child, even if the child's grasp of that influence is not yet realized.

Within dynamic systems theory the influences of Piaget and Vygotsky are also felt. Van Geert's (2000) dynamic modeling theory for development outlines two forces that are present within dynamic development models and can also be seen in my model. The conservative force strengthens the existing reltionships between systems can be seen in my model by the evolution of the arrows connecting systems and returning to the child. The emergence of new relationships and new systems into my model can be related to the progressive force that drives change within the dynamic model. However, Van Geert recognized that developing dynamic models, while helpful, is incomplete without verification through testing and observation. This presents a new difficulty in verifying dynamic models. Verification of models such as my own would require longitudinal studies of great length and complexity, both expensive and time-consuming, with difficulty in tracking individuals over an extended period of time.

It is my intent that an educator may use this model both to seek commonality between students within a population, and to highlight applicable differences that can benefit the group dynamic. As I progressed along the journey that became this report, I have kept it my goal to develop a model that could be used by an educator to clarify the influences on the child at each life stage so that they may be accounted for and anticipated. Although it is not possible to tailor instruction individually to each student in a large public school classroom, this model may help educators to identify key information about their focal population, drawing on commonalities and differences, so that instruction may be tailored to maximum effectiveness.

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